Evaluation and Selection of a GaN Power-Amplifier Die for Flip-Chip Integration on a Glass CPW Interposer

Daniel Tyukov
B.Sc. Thesis, Integrated Circuits Dept.
Electrical Engineering, Eindhoven University of Technology
Eindhoven, The Netherlands
daniel.tyukov@student.tue.nl

***Abstract*—This paper presents a comparative data-sheet study of seven commercially-available GaN-on-SiC bare dies with the goal of selecting a power-amplifier device for subsequent flip-chip bonding onto a gold–titanium coplanar-waveguide (CPW) glass interposer. Key constraints are: *(i)* ≥3 W output power, *(ii)* DC–GHz bandwidth, *(iii)* pad opening ≥75 µm to support thermo-acoustic gold-bump attachment, and *(iv)* peak drain current ≥1 A. Of the seven candidates, four satisfy every criterion; the Qorvo TGF2933 die offers the best compromise of electrical performance, die area, and assembly compatibility.**

I. Introduction

Glass interposers with low-loss CPW routing enable compact RF front-ends. To minimise parasitics, active dies are flipped and bump-bonded directly to the Au/Ti CPW pads. Selecting a suitable GaN power-amplifier die therefore requires not only meeting electrical specifications but also ensuring mechanical and metallurgical compatibility with the flip-chip process.

II. Design Requirements

Table I summarises the mandatory targets communicated by the interposer technology team and overall system specification.

TABLE I
PROJECT REQUIREMENTS

Parameter	**Target**
Package style	Bare die (no lid)
Frequency range	DC to ≥6 GHz
Output power	>3 W (P_{SAT})
Peak drain current	≥1 A
Pad opening	≥75 µm (square or equivalent)
Top metal	Au compatible with bumping
Attachment	Thermo-acoustic Au bumps (flip-chip)

III. Candidate Devices

Seven GaN HEMT dies were shortlisted based on public availability and price ceiling ($ 50, not further discussed here). Device parameters extracted purely from the latest vendor data-sheets are compiled in Table II. Die area was calculated from published die dimensions.

IV. Suitability Discussion

A. Electrical Criteria

Four dies (GRF0030D, TGF2933, TGF2023-2-02, TGF2023-2-01) satisfy the ≥1 A current limit. All meet the 3 W output-power floor, with GRF0030D vastly exceeding it but at the cost of greater footprint and thermal dissipation. TGF2933 provides a balanced 7 W capability with broadband operation to 25 GHz, covering present and future demonstrator needs.

B. Thermal Considerations

Die area correlates with junction-to-interposer thermal resistance. TGF2933's $0.459\,\mathrm{mm}^2$ footprint yields the lowest thermal path, while GRF0030D's $1.23\,\mathrm{mm}^2$ size adds 2× spreading resistance. For the intended glass interposer, through-glass heat-spreader vias will be placed under the die; a smaller die minimises via count and routing blockage.

C. Biasing and System Impact

Higher drain voltages demand wider CPW traces for breakdown margin. The 28 V class (TGF2933, GRF0030D) is preferred over 32–40 V devices to ease interposer design and reduce E-field at bump shoulders.

V. Device Selection

Considering all factors—electrical compliance, die area, bias voltage, bump complexity, and thermal design—the **Qorvo TGF2933** is selected as the optimal die for the demonstrator build. It meets or exceeds every requirement while minimising integration risk and interposer real estate.

VI. Conclusion

A comprehensive data-sheet audit of seven GaN HEMT bare dies identified four electrically suitable devices for a flip-chip glass CPW interposer. The Qorvo TGF2933 offers the best overall fit, combining adequate output power, ample current headroom, compact area.

TABLE II
DATA-SHEET COMPARISON OF ALL SEVEN GaN HEMT BARE DIES

Die	F_{range} (GHz)	P_{SAT} (W)	I_{MAX} (A)	Gain (dB)	Pad min (μm)	Die area (mm^2)	Meets reqs?	Flip-chip notes
CGH60008D	DC–6	8	0.75	15	$\sim$100	0.755	**No** (current)	Au pads/backside OK; would need derated operation [1].
CGHV1J006D	0.01–18	6	0.80	17	202×102	0.672	**No** (current)	Au pads; high 40 V bias increases CPW voltage stress [2].
GRF0030D	DC–6	50	1.54	23.7	$\sim$100	1.23	**Yes**	Large die area raises cost and thermal load [3].
GRF0020D	DC–7	30	0.91	24.3	$\sim$100	0.955	**No** (current)	Near-limit current; otherwise suitable [4].
TGF2933	DC–25	7.2	2.0	15	90	**0.459**	**Yes**	Smallest die, 28 V bias, Au pads/backside, two active bumps [5].
TGF2023-2-02	DC–18	12	2.5	14.9	115	0.754	**Yes**	Higher 32 V bias; three-pad topology increases bump count [6].
TGF2023-2-01	DC–18	6	1.44	18	115	0.541	**Yes**	Electrical fit; assembly notes focused on wire-bonding [7].

REFERENCES

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